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TECHNIQUES OF FARM SURVEY [1]

SHAO-ER ONG, H. VON OPPENFELD and E. U. QUINTANA

Before discussing farm survey techniques, it is necessary to present a general picture of the progress of farm management research work done in the Western countries, particularly the United States of America, and the role of farm surveys in the farm management research. This background information will enable us to appraise the possibility of applying the same procedures in this region.

The Progress of Farm Management Research

The development of systematic farm management research in the United States started about 50 years ago. "Cost study" and "farm accounting" were conducted first in a few selected farms; then developed the "farm survey" to cover more farms and a wider area. When survey data were available, "type-of-farming" studies were also carried out in each State. As both accounting and survey were collecting data for the past, government agencies and land-grant colleges wanted to help farmers plan for the future. With such motive, "Agricultural Outlook Conferences" were held in each State to project what will happen in agriculture in the next five or ten years. By adopting the farm budgeting methods, farm planning for profit and stability became popular. To assist farmers in preparing better farm plans, both "input-output" studies, by applying the principle of variable proportion, and "inter-regional competition" studies, by applying the law of comparative advantage, were promoted. When labor shortage became acute during two world wars, "farm work simplification" studies received much attention. Recently, equal emphasis has been given to "production economics" on the one hand and relationship between agriculture and non-agriculture on the other hand.

Considerable progress has been made in farm management research in the United States, both in methodology and magnitude.

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[1] General Contribution No. 880. This paper was presented and discussed by the authors at the FAO Farm Management Development Center for Asia and the Far East, October 15 to November 10, 1956, Tokyo, Japan.

In applying known procedures and techniques to this region, two questions will arise. Shall we attempt to follow a similar pattern proceeding step by step in developing farm management research in this region or are there any short-cut methods? Shall we apply the same methodology in the steps that seem to be applicable to this region?

In the case of cost study, we can well understand that in the States most farms are large and specialized in one crop. Even if they grow two crops, they grow them in separate fields. This makes crop study simpler. In this region, one plot of land grows two or three crops. Many difficulties will therefore be involved in breaking down overhead cost or joint cost. In keeping farm accounts, the problem in the Western countries is also simpler because their farmers in general are better educated. They know how to read and how to write, while the majority of our farmers are illiterate.

Taking farm survey records in this region also faces the difficulty of suspicion from farmers. They suspect that the motive of interview may be tax collection. Even after sincere and repeated explanation, they will still hesitate to tell the truth. With incomplete data it will be difficult to make accurate and detailed analysis.

Most countries in this region do not have complete physical information on climate, topography and soils. At the same time, few large-scale cost accounting or farm surveys have been carried out. Without both physical and economic data, there are no bases to make type-of-farming studies and to project agricultural outlook. Though several studies on input-output relationship have been tried, the main difficulty is that the measurement units of both input and output need standardization. For instance, unless the labor unit, both man and animal is standardized it is difficult to measure the input of labor and output of products. With regards to farm work simplification, our main emphasis should not be to save more surplus labor, but to shift labor saved from one operation to another operation for production purpose. There is room for farm work simplification, particularly during the peak period, such as plowing, sowing or harvesting of crops. It will also reduce the cost of production.

The foregoing discussion pointed out the progress of farm management research program in the Western countries, and the difficulties in carrying out similar research in this region. Under present conditions in this region, we have to devise means and methods to

overcome these difficulties and to push ahead farm management studies in order not to lag behind the progress made in the Western countries.

Role of Farm Survey

The purpose of research is to solve a problem or problems. The first step of research is to state the problem clearly, and next, to set up certain hypotheses. Each hypothesis will indicate some relationship to be tested or verified. When the relationship is established, the research worker will know where to go and how to get there. It is also necessary to appraise the logic, the problem and hypothesis with past experience or some applicable and relevant economic theories. Purely theoretical reasoning is not sufficient. The most important part is to collect the needed quantitative data to test the validity of the hypothesis by statistical means. If the quantitative data prove the validity of the relationship, this hypothesis is accepted as valid. Otherwise the hypothesis is rejected as invalid. The findings of such research will be very useful in suggesting alternatives in policy formulation to solve said problem.

The question now is how to get the quantitative data to verify the validity of our hypothesis. To this end, we must collect the data directly from the farmers by means of farm survey method. Before collecting quantitative data, one has to define his problems clearly first. Otherwise, the procedure involves merely the compilation of data rather than problem solving. In this regard, it is necessary to differentiate farm survey from farm census. Farm survey is to collect needed data for specific problems and farm census is to collect all general information. When preparing a survey schedule, some relationship must be assumed there. For instance, when information on farm size is collected, the data on farm income must be available in order to show the relationship between the size and income. From a set of good farm records, one can discover and verify many relationships in connection with the problem studied.

It must be pointed out that farm survey is only one of the methods used in farm management research. This method has both limitations and advantages. First, farm survey collects only past information. During the interview, farmers will answer questions regarding their business of one or two years ago from memory. The past may not be repeated exactly in the future. However, not all farming conditions will be changed within a short period of time, particularly conditions in this region which are more or less static.

After a certain length of time some things may change. Second, data collected from farms is limited to a given period of time. Generally speaking, it covers one farm business year which varies from country to country. In some countries the agricultural calendar year starts from July 1 to June 30, in others from April 1 to March 31, and still in others, from January 1 to December 31. If this agricultural year is not a normal year, *i.e.,* it is either too dry or too wet, the survey results must be carefully interpreted in order to give a correct picture of the business situation.

Careful consideration should be given to the following points when one undertakes the farm survey. First, ask what we want. Information not relevant to our stated problem should be omitted. Second, the schedule should be clear, simple and short, whether it is in table form or in a questionnaire form. Farmers are not prepared to answer lengthy questions on complicated matters. Third, the survey must be representative. This depends on a sound sampling technique. To conduct farm survey in one area, the sample should be based on different types of farming or different types of soil, or different sizes of farm. Since it is not possible, and also not necessary to interview every farm household in an area, the results from some selected farms should be representative. Fourth, the record must be complete. That means every item listed in the schedule must be filled with either positive or negative answers. The records should be checked, and summarized immediately after interview. One can easily check the accuracy of data from a farm business record. For instance, we can ask the kind of land used first, which includes land used for growing crops, for pasture, farmstead, etc. When asking about the cropping system, the total area for crops must be the same as indicated in land use. In case the farmer does not tell us the number of hens he has, later on, if he mentions how many eggs are collected annually, we know the approximate number of hens. From the availability of family labor and hired labor, one can also check whether the amount of work in the farm is too much or too little. The enumerators must check these things on the spot and have all records completed before tabulation.

Certainly the training of enumerators is very important. This problem is particularly important in our region here. In the United States the research workers go to the farms themselves to interview the farmers and to study their problems. They can go by car.

The farmers with high income who own nice homes are actually capitalists. Hence there is no problem of social prestige. The condition in this region seems different. The high-ranking research workers may find it inconvenient to go to the fields themselves to discuss the problems with the small farmers. As a matter of fact, most of the high-ranking research workers are government officials who are beyond the reach of farmers. Even if they would go, the famers are afraid of them and do not know how to entertain them. Under such condition, the survey work is usually done by very low-ranking officials who have little knowledge of survey method and even agricultural background. To overcome such difficulty, the enumerator must be well trained. Otherwise, if the quantitative data is not reliable, the findings of study cannot be used to justify the validity of hypothesis and the findings used in policy implications will be very misleading.

The main advantage of farm survey is its inexpensive implementation. This is particularly important in this region where many a government or research institution is short of research funds. The cost of preparation, supervision, and tabulation of farm survey is relatively less than other methods. At the same time, with sound sampling technique, the result of farm survey is as good as other methods used in farm management research.

Measures of farm efficiency

Farm efficiency factors, as used in farm survey, are the size of farm business, labor efficiency, and rate of production.

Size of farm business. There are several measures of the size of a farm business. Total area is most commonly used. Other general measures include total capital, total crop area, and total productive man-work units. Before using any one of these measures, one has to take into account the crops, livestock and other income-producing work on the farm.

To measure size of business between two farms, one with an income of ₱1,000 and another with ₱1,500, it would be difficult to indicate which farm has larger size unless some accurate yardsticks are used. For instance, if the former farm has a size of 10 hectares and the latter, 5 hectares, the smaller farm has earned more income than the larger one. It may be due to the fact that the small farm grows more crops or has better combination of enterprises. Under a diversified type of farming, it would be better to use productive

man-work unit to measure the size. Total labor requirement will represent more accurately the size of business than the size of farm. If the farms grow the same crop, then the use of land area for comparison purposes will be justified.

Labor efficiency. The methods used to measure labor efficiency are as variable as those used in measuring the size of farm business. In general, crop area or the hectares of crops per man, is a good measure. On dairy farms, the number of cows per man is commonly used. The amount of milk produced or sold per man is also useful. In an area where farmers have more than one important enterprise, the total productive man-work units per man-equivalent is a sound measure.

With regards to the calculation of man-equivalent, we have to study the actual condition in this region. First, the efficiency of female and child labor is not the same as that of male labor. Secondly, there is a wide range of climate. The standards used in measuring man-equivalent have to take into account the difference in efficiency due to age, sex, and climate. By the same token, reasonable standards should be set up in this region to measure the productive animal-work unit.

Rate of production. Rate of production is measured in terms of crop yield per hectare, the amount of milk produced per cow, the number of eggs laid per hen, or pigs farrowed and reared per sow. To compare the crop yields between farms in a diversified type of farm where many crops are grown, it is necessary to use crop index. The method used in computing crop index is illustrated in Dr. Yang's "Method of Farm Management Investigation."

The scientific calculation of these three farm efficiency factors will help in finding the relationship between one of the factors and income or the combination of these three factors and income.

Measures of farm income. There is no one best measure of farm income in this area. Labor income, widely accepted as a measure of operator's net farm income in the United States, was developed under conditions of commercial farming. It has serious shortcomings where these conditions do not prevail. First, it is difficult to determine proper rates for family farm labor under conditions of surplus labor and limited employment opportunities. Second, labor income does not include the value of home-consumed farm produce which

[2] W. Y. Yang, "Methods of Farm Management Investigations," FAO, 1956.

may account for a large share of family farm income. Third, land values and interest rates, frequently subject to arbitrary assumptions, make it difficult to arrive at objective charges for land use.

To overcome the first two of these objections, *family farm labor earnings* is suggested as a measure. It represents returns to operators and family farm labor and management. For relationship between farm income and factors affecting success this measure is well adapted.

Total income of rural families is best expressed by a measure called *family income from all sources.* This represents income of the operator and family members from farm and non-farm labor. Neither unpaid family labor nor interest on farm capital are considered as imputed charges. Including income from all sources, this measure reflects the amount available to the household as a consumption unit.

Which one of these two measures is preferable depends upon the nature and objective of the study. Further adaptations may be necessary.

* * *

There are three factors that decide the fate of any farmer anywhere, namely: (a) the size of the land that he cultivates; (b) the success or failure of his crop; and (c) the price that he afterwards gets by selling his products.

—*Manuel Gallego*

ESTIMATING THE LIVEWEIGHT OF BERKJALA, BERKSHIRE, AND BERKJALA-BERKSHIRE CROSSES FROM BODY MEASUREMENTS [1]

J. A. Eusebio, G. B. Garcia and S. C. Salmon

WITH TWO TEXT FIGURES

The body measurements and weights showed variations at different ages for both breeds. Pigs of both breeds and crossbreeds had greater body length than heartgirth; the body measurements showed a highly significant correlation in weight.

The weight of Berkjala pigs can be estimated by using second degree polynomial equations from heartgirth and body length individually, and by multiple correlation using simultaneously its heartgirth and length. The equations to be used are: $Y = 207.0 - 4.7922\ X + .033963\ X^2$ (heartgirth); $Y = 8.5 - .670629\ X + .011739945\ X^2$ (length), and $Y = 2.2314\ X_2 - .0350405\ X_1 - 157.8$ (multiple correlation, wherein X_1 stands for the heartgirth and X_2 for the body length).

The weight can be calculated for Berkshire pigs with the following equations: $Y = .13839\ X + .0099\ X^2 - 32.23$ (heartgirth); $Y = 156.8 - 3.584\ X + .0254\ X^2$ (length) and $Y = 2.43\ X_1 + .124\ X_2$ (multiple correlation, X_1, heartgirth and X_2, length). The equations for the Berkjala $\times$ Berkshire in calculating the liveweight are: $Y = .3904\ X + .0074\ X^2 - 35.30$ (heartgirth); $Y = 140.81 - 3.1935\ X + .02305\ X^2$ (length). The multiple correlation is $Y = 1.328\ X_1 + 0.745\ X_2 - 137.21$, wherein X_1 is the heartgirth, and X_2 is the length.

Most swine raisers do not possess scales. When their animals are sold by the head, determination of the liveweights is often guesswork. Hence, poor marketing results.

Previous studies show that there is considerable opportunity to use to estimate liveweight. Winters (1948) stated that the weight of hogs can be calculated to a remarkable degree of accuracy based on measurements of heartgirth and body length. He proposed the formula: Heartgirth $\times$ heartgirth $\times$ body length (in inches) $\div$ 400 $=$ weight in pounds. He found that the formula is more accurate when used on hogs under 300 pounds than on heavier animals. Morris and Zavoral (1948), claimed that there would be greater ac-

[1] Central Experiment Station Contribution No. 1943. Research Project No. 929.

curacy, especially on mature hogs, if the weights obtained by the formula are adjusted in accordance with the table shown below for hogs of various weights:

WEIGHT OBTAINED BY FORMULA (pounds)	ADJUSTMENT NEEDED (pounds)
Under 150	Add 7
150 – 400	no adjustment
401 – 425	subtract 10
426 – 450	" 20
451 – 475	" 30
476 – 500	" 40
501 – 525	" 50
526 – 550	" 60
551 – 575	" 70
over 575	" 80

Gonzalez and Cabrera (1949), showed that weaning weight could be used to some extent to predict the weight at 154 days of age. Gonzalez (1952), found that weight of hogs at 168 days of age can be estimated with some accuracy from their length, heartgirth, and flank girth. The equation he used was $Y = 7.058\ X_1 + 2.611\ X_2 - 0.420\ X_3 - 231.09$, wherein X_1 stands for the length, X_2 for the heartgirth, and X_3 for the flank girth, each in inches. Similar estimates could be made for other ages, but with less accuracy than at 168 days of age.

Because of differences in climate, among other factors, the formula which works well for hogs raised in temperate areas may not work as well for hogs raised in the tropics. This study was therefore conducted to evolve a working formula for pigs raised locally. The work was undertaken at the Department of Animal Husbandry from July, 1956 to April, 1957.

EXPERIMENTAL PROCEDURE

Twenty Berkjala, 20 Berkshire and 12 Berkjala-Berkshire crosses from the College swine herd, classified according to breadth, age and sex, and randomly selected, were used. The weight (in kilograms) and body measurements (in centimeters) of the heartgirth and length of each pig were determined twice a day for three consecutive days. The average of the six measurements on each individual was taken as representative of the measurements.

The body length was measured from the poll (a point midway between the ears) to the base of the tail. The heartgirth was the circumference of the body at the chest immediately behind the point of the elbow. The position of the head is particularly important when measuring the body length; it should be held as shown in figure 1.

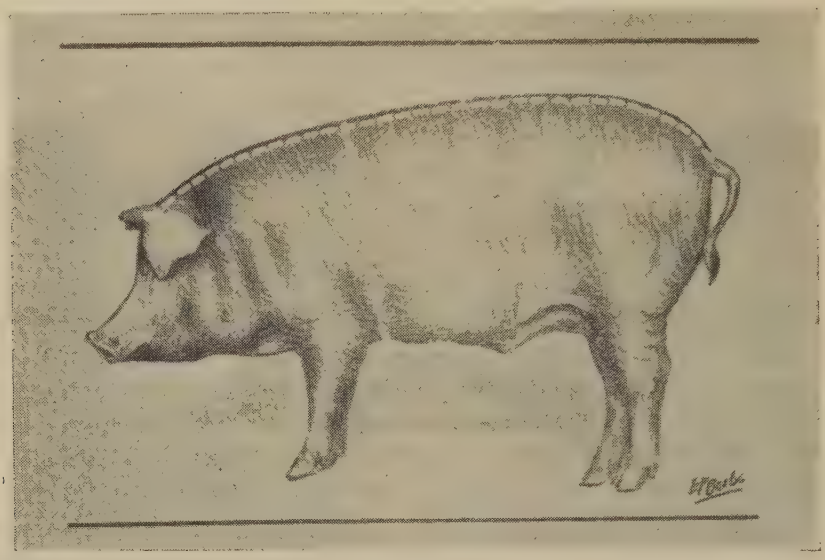

Fig. 1.—Body measurements and position of the head for estimating live-weight in hogs.

Multiple regressions and second degree polynomials outlined by Snedecor (1956), were used in the study of the relationships.

RESULTS AND DISCUSSION

Measurements as related to breed and sex

The averages of the measurements of body length and heart-girth and actual weights of the two breeds and the Berkjala-Berk-shire crosses are shown in table 1. The body measurements and weights showed variations at different ages for both breeds.

The average body lengths of all groups were greater than those of heartgirth. Winters and Green (1944), found that different strains of swine change body proportion at different ages. Com-stock and Winters (1944) and Winters (1948), stated that swine change form as they grow and as weight increases and these changes are subject both to genetic and environmental causes.

TABLE 1.—*Average length, heartgirth and height of the pigs at time measurements were taken*

CLASSIFICATION	BERKJALA					BERKSHIRE					BERKJALA-BERKSHIRE CROSSES				
	No. of animals	Age (mos.)	Length (cm.)	Heart-girth (cm.)	Actual weight (kg.)	No. of animals	Age (mos.)	Length (cm.)	Heart-girth (cm.)	Actual weight (kg.)	No. of animals	Age (mos.)	Length (cm.)	Heart-girth (cm.)	Actual weight (kg.)
Young barrow	2	6	80.9 ± 1.02	77.9 ± 1.13	35.2 ± 1.15	2	5	76.70 ± 0.98	72.10 ± 1.00	28.02 ± 0.55					
Junior yearling barrow	6	8.6	91.1 ± 2.70	83.3 ± 1.17	47.1 ± 1.38	2	14.3	122.1 ± 1.16	116.1 ± 0.60	102.9 ± 0.88	4	10	105.08 ± 0.51	90.04 ± 0.81	61.89 ± 0.67
Gilt	4	11	103.8 ± 1.08	98.2 ± 1.29	69.4 ± 2.03	7	18.0	131.44 ± 1.89	119.88 ± 2.27	125.81 ± 5.73	6	9	103.38 ± 0.96	86.42 ± 0.70	54.32 ± 2.30
Sow	4	28.2	134.06 ± 2.06	123.14 ± 1.59	127.14 ± 4.72	7	28.5	134.79 ± 1.24	118.93 ± 1.71	130.26 ± 4.90	2	26.5	131.6 ± 1.14	122.2 ± 1.09	125.6 ± 3.96
Mature boar	2	58	160.4 ± 3.80	139.5 ± 1.64	212.4 ± 10.9	2	49.6	161.2 ± 2.03	157.0 ± 2.21	247.0 ± 9.64					

Correlation between measurements and weights

Zero order correlation coefficients between both measurements and between weights and either of the body measurements were obtained (table 2). Although the animals used in this study represent different breeds and age, it was thought that the information gathered would be of great value to our farmers in the islands. Most swine herds in the Philippines include several breeds or a mixture of breeds and of different ages. All coefficients were statistically significant at the one per cent level; and numerically high too, the least being 0.918. Godbey *et al.* (1949) worked with Berkshire barrows and found that there was a significant correlation for length, heartgirth, and weight at 168 days of age.

TABLE 2.—*Correlation between length and heartgirth measurement and weights of swine*

ITEMS CORRELATED	BERKJALA				
	D.F.	r	Tabular r		Prob.
			.05	.01	
Weight and length	19	.980	.433	.549	<.01
Weight and heartgirth	19	.954	.433	.549	<.01
Length and heartgirth	19	.974	.433	.549	<.01

ITEMS CORRELATED	BERKSHIRE				
	D.F.	r	Tabular r		Prob.
			.05	.01	
Weight and length	19	.918	.433	.549	<.01
Weight and heartgirth	19	.966	.433	.549	<.01
Length and heartgirth	19	.945	.433	.549	<.01

ITEMS CORRELATED	BERKJALA × BERKSHIRE				
	D.F.	r	Tabular r		Prob.
			.05	.01	
Weight and length	11	.956	.553	.684	<.01
Weight and heartgirth	11	.980	.553	.684	<.01
Length and heartgirth	11	.934	.553	.684	<.01

Estimation of weight from body measurements

Two methods of estimating weight based on body measurements seem to be available by multiple correlation and by using second degree polynomials. The first has the advantage that all three

variables can be incorporated in one formula but suffers from the fact that it assumes a straight line relationship. The second provides for curvilinear relations but two separate estimates of weight must be made, one based on body length and the second on heartgirth. In other words the method of multiple correlation would be most convenient if it can be justified.

Figures 2a and 2b show the distribution of length and weight and of heartgirth and weight of each of the three classes of animals.

The weight of swine of any age from different breeds and crosses could be calculated with fairly accurate results from the following equations (Snedecor, 1946):

a. Second degree polynomial from heartgirth:

Berkjala: $Y = 207.0 - 4.7922 \times .033963\ X^2$
Berkshire: $Y = .13839\ X + .0099\ X^2 - 31.23$
Crossbreed: $Y = .3904\ X + .00744\ X^2 - 35.30$

wherein X stands for the heartgirth in centimeters. The following are correlation coefficients upon which these equations are based: Berkjala, .9979; Berkshire, .975; and Berkjala × Berkshire, .991.

b. Second degree polynomial from body length:

		R
Berkjala:	$Y = 8.5 - .670629\ X + .011739945\ X^2$.	0.9804
Berkshire:	$Y = 156.8 - 3.5843\ X + .0254\ X^2$	0.9663
Crossbreed:	$Y = 140.81 - 3.1935\ X + .023049\ X^2$ ..	0.8583

wherein X stands for the body length in centimeters.

c. Multiple correlation with heartgirth and body length:

		R
Berkjala:	$Y = 2.2314\ X_2 - .0350405\ X_1 - 157.8$ ...	.9801
Berkshire:	$Y = 2.43\ X_1 + .124\ X_2 - 163.2$	.9637
Crossbreed:	$Y = 1.328\ X_1 + 0.745\ X_2 - 137.21$	.986

wherein X_1 stands for the heartgirth in centimeters and X_2 for the length in centimeters.

From each equation by second degree polynomial and multiple correlations, the weights of the animals used were calculated. Each estimated weight compared to the actual weights of the same animal was studied. The differences of the actual and estimated weights were taken to find the standard deviation from each breed. With the Berkjala, the standard deviation of the differences of the actual and estimated weight using polynomial by the length was ± 7.81; and from its heartgirth, ± 12.43. Using the multiple correlation, the standard deviation of the same breed was ± 1.17. When

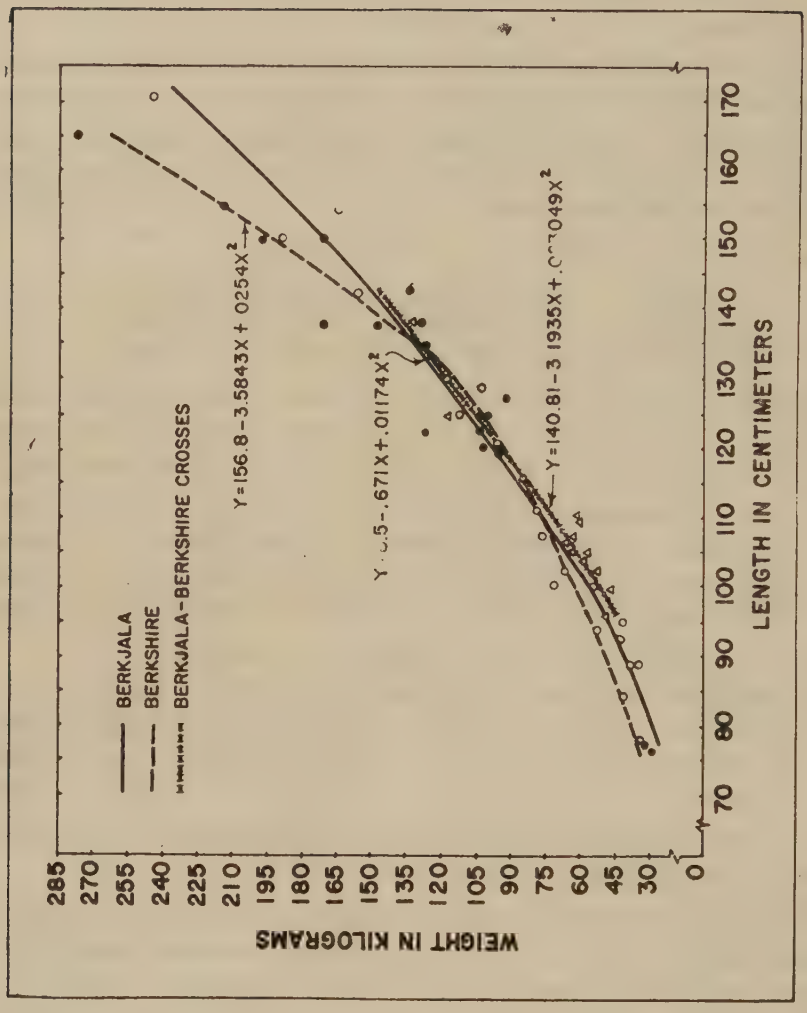

Fig. 2a.—Graph of second degree polynomial for length and weight fitted to Berkjala, Berkshire and Berkjala-Berkshire crosses.

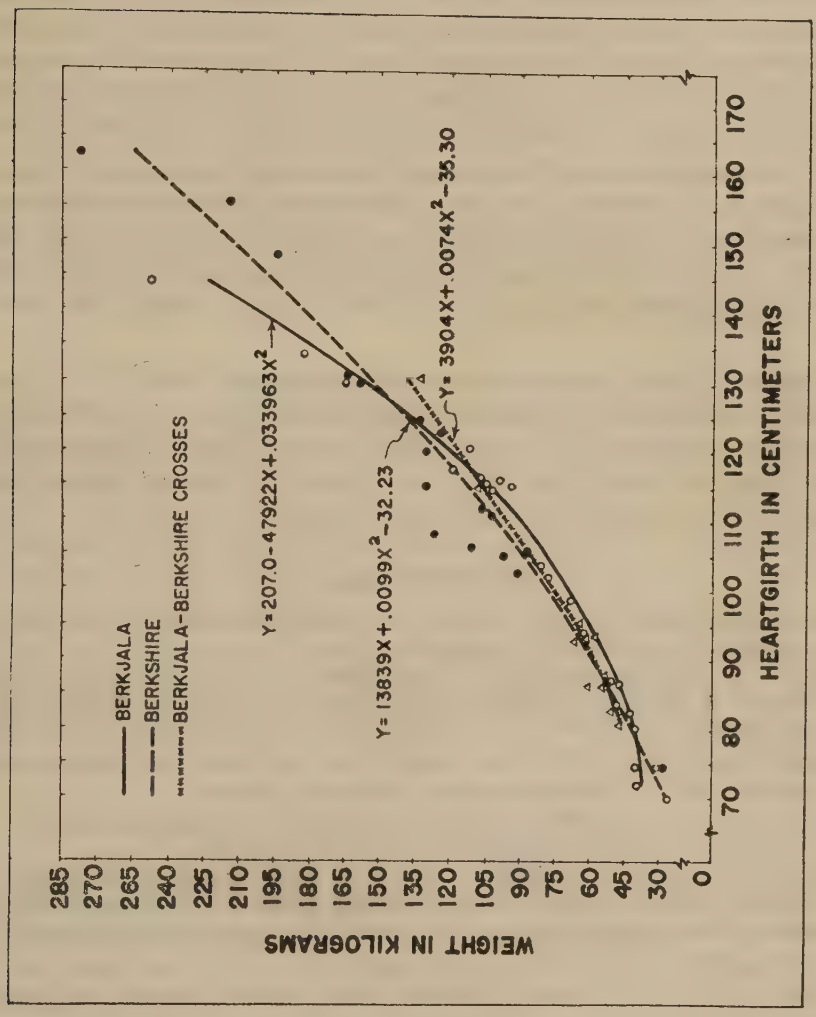

Fig. 2b.—Graph of second degree polynomial for heartgirth and weight fitted to Berkjala, Berkshire and Berkjala-Berkshire crosses.

the Berkshire breed was examined, the standard deviation of weight differences for the heartgirth and length by second degree polynomial were ±13.05 and ±15.13, respectively. On the other hand, using the multiple correlation, it was found that the standard deviation of the differences in weights was ±4.16. For the crossbreed, the standard deviation of weight differences using the second degree polynomial by its heartgirth and body length were ±5.10 and ±9.34, respectively. In the multiple correlation calculation for standard deviation of the differences in weight, the value was much lower being ±1.60.

The theoretical equation curves in the second degree polynomial of length and heartgirth are almost the same in Berkjala, Berkshire and crossbreed as regards the departure from the linearity (figs. 2a and 2b). However, two cases in the Berkjala deviated from the theoretical equation because an old boar and a pregnant sow were used.

These different values of standard deviations would be an important consideration in selecting the method to use in estimating liveweights later on. It is hoped that the writers shall put out a single formula, which will hold true for all classes of animals of different strains, based on the present findings.

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SOME ORGANIC INSECTICIDES IN THE CONTROL OF CABBAGE WORM [1]

G. B. Viado, A. F. Banaag and S. E. Moresto [2]

Diazinon was the best of five insecticides tested for the control of the cabbage worm, *Pieris canidia*, giving complete control throughout the test. Endrin, the second best, gave only 26.12 per cent control but the damage was very light and the plants were able to produce normal heads. All the plants in the control were infested four weeks from the start of the test; those in the Heptachlor, five weeks; in the DDT, six weeks; and in the Guthion, eight weeks. The Diazinon treatment produced the highest number of marketable heads with the highest average weight per head. The order from the most to the least effective based on infestation counts and yield were: Diazinon, Endrin, Guthion, DDT, and Heptachlor.

DDT which was formerly the standard insecticide for the control of cabbage worm, *Pieris canidia* Sparrman, in Mountain Province, has been replaced by Endrin. However, with the continuous use of Endrin alone year after year, it is quite probable that a strain of the pest resistant to this insecticide might develop and Endrin may eventually be replaced by another insecticide or a combination of insecticides for the control of this insect.

To prepare for this eventuality, the authors conducted a test to determine the efficacy of new insecticides in controlling cabbage worm compared to DDT. The test was undertaken in Trinidad Valley, Mountain Province, during the 1956-1957 crop season.

MATERIALS AND METHODS

A commercial variety of cabbage, "Copenhagen Market" was used in the test. The plants were set in the field and given the same care and attention as in commercial plantings. Before and after transplanting in the field the seedlings were examined daily and freed from eggs and larvae until the first spray application, after which natural infestation was allowed to set in until the end of the test.

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[2] G. B. Viado and A. F. Banaag are research associate professor and research assistant respectively in the Department of Entomology, College of Agriculture, U.P. S. E. Moresto is instructor in the Mountain National Agricultural School.

The insecticides tested were all emulsifiable concentrates (EC) and their proportions per 100 gallons of water were:

DDT, 25% EC	2 pints
Endrin, 19.5% EC	1 pint
Diazinon, 20% EC	1 pint
Guthion, 20% EC	1 pint
Heptachlor, 23.4% EC	2 pints

Ten spray applications of one-week intervals were made, the first applied two weeks after transplanting. Care was taken to spray thoroughly both surfaces of the leaves. Counts of infested plants were made before each spray application to determine progress of infestation. Compression hand sprayers of two-gallon capacity equipped with ordinary high-volume nozzle were used.

DISCUSSION OF RESULTS

To secure a sound basis for evaluating the insecticides under test, infestation before the first spray application was made as negligible as possible. This was done by removing and destroying all larvae and eggs on the plants daily. The eggs which could readily be seen with the naked eyes were laid singly on the leaves.

The weekly infestation counts show the progress of natural infestation from the start of the test to harvest (table 1). One week after the start of the test, all the plots except those treated with Diazinon and Endrin were infested, with the control receiving the brunt of the infestation. After the second week, only the plots treated with Diazinon were not infested. The treatments arranged in the descending order of intensity of infestation up to harvest were control, Heptachlor, DDT, Guthion, Endrin and Diazinon.

Four weeks after the start of the test all plants in the control plots were infested. It took five weeks before all the plants treated with Heptachlor were attacked, six weeks in the case of the DDT treatment, and eight weeks in that of Guthion. At harvest, all the plants in the Diazinon-treated plots were not infested while in the Endrin treatment only 26.12 per cent were not infested. The differences between the control plot and all the treatments in all observations were highly significant. The best treatment was Diazinon. Endrin was a poor second and Guthion, a very poor third. Heptachlor was the poorest, closely followed by DDT. There was not much difference between the control and Heptachlor. In two replicates

there were more infested plants in the Heptachlor-treated plots than in the control plot.

TABLE 1.—*Mean per cent infested plants at different dates of observation* [a]

TREATMENT	MARCH 11		MARCH 18		MARCH 25		APRIL 1	
	Actual mean	Mean angle	Actual mean	Mean angle	Actual mean	Mean angle	Actual mean	Mean angle
DDT	19.38	26.00	38.13	38.07	65.63	54.46	80.63	68.55
Guthion	1.25	2.88	3.13	4.65	6.87	13.69	15.00	22.21
Endrin	0	0	0.62	2.03	1.25	2.88	5.62	11.94
Heptachlor	24.37	28.82	55.00	48.43	78.75	65.26	98.75	87.12
Diazinon	0	0	0	0	0	0	0	0
Control	40.62	39.03	69.38	62.63	96.25	84.86	100.00	90.00
S.M.D. (T) at 5%		9.81		16.55		12.46		12.67
S.M.D. (T) at 1%		13.38		22.58		17.00		17.28

TREATMENT	APRIL 8		APRIL 15		APRIL 22		APRIL 29	
	Actual mean	Mean angle	Actual mean	Mean angle	Actual mean	Mean angle	Actual mean	Mean angle
DDT	97.00	83.70	100.00	90.00	100.00	90.00	100.00	90.00
Guthion	32.50	34.70	57.35	49.32	93.97	79.71	100.00	90.00
Endrin	13.03	20.97	27.42	31.46	45.60	42.44	58.65	50.02
Heptachlor	100.00	90.00	100.00	90.00	100.00	90.00	100.00	90.00
Diazinon	0	0	0	0	0	0	0	0
Control	100.00	90.00	100.00	90.00	100.00	90.00	100.00	90.00
S.M.D. (T) at 5%		5.65		3.99		6.12		2.32
S.M.D. (T) at 1%		7.71		5.44		8.34		3.17

[a] No infested plant was noted before the first spray application on March 4, 1957.

The number and weight of heads in the various treatments show very striking differences (table 2). The Diazinon treatment gave the highest total number of heads (138) with a total weight of 87.54 kilograms compared with only 24 heads with a total weight of 9.35 kilograms in the control. Endrin was next best, followed by Guthion, DDT and Heptachlor. The differences between treated and the control in both the total number and weight of heads were highly significant. The heads in the Diazinon treatment (table 3) were the biggest and heaviest in the lot, averaging 0.63 kilogram per head compared with only 0.37 kilogram in the control. Endrin was a close second and Guthion a poor third. The heads in the DDT and Heptachlor treatments were as small and as light as those in the control.

TABLE 2.—*Total number and weight of heads harvested based on one hundred sixty plants per treatment*

TREATMENT	REPLICATION										TOTAL		MEAN	
	I		II		III		IV		V					
	Number	Weight kgm.	Number	Weight kgm.	Number	Weight kgm.	Number	Weight kgm.	Number	Weight kgm.	Number	Weight kgm.	Number	Weight kgm.
DDT	10	3.77	13	4.09	8	2.91	14	5.41	15	6.00	60	22.18	12.0	4.44
Guthion	16	7.64	18	9.18	15	7.04	21	9.68	22	7.68	92	41.22	18.4	8.24
Endrin	28	18.36	20	11.00	26	13.95	20	11.59	29	17.77	123	72.67	24.6	14.55
Heptachlor	7	2.68	8	3.59	4	1.32	13	4.95	9	3.68	41	16.22	8.2	3.24
Diazinon	30	21.04	28	15.73	24	17.00	32	19.77	24	14.00	138	87.54	27.6	17.51
Control	3	1.18	4	1.54	5	1.86	6	2.36	6	2.41	24	9.35	4.8	1.87
Total	94	54.67	91	45.13	82	44.08	106	53.76	105	51.54	478	249.18		

TABLE 3.—*Mean weight per head in kilograms*

TREATMENT	REPLICATION					TOTAL	MEAN
	I	II	III	IV	V		
DDT	0.38	0.31	0.36	0.39	0.40	1.84	0.37
Guthion	0.48	0.51	0.47	0.46	0.35	2.27	0.45
Endrin	0.65	0.55	0.54	0.58	0.61	2.93	0.59
Heptachlor	0.38	0.45	0.33	0.38	0.41	1.95	0.39
Diazinon	0.70	0.56	0.71	0.62	0.58	3.17	0.63
Control	0.39	0.38	0.37	0.39	0.40	1.93	0.39
Total	2.98	2.76	2.78	2.82	2.75	14.09	

The highest average number of marketable heads per plot (27.6) was registered in the Diazinon lot. Only an average of 86.25 per cent of the plants in this treatment, however, produced marketable heads (table 4). The few plants left, although not infested, were very late in forming heads and were not considered at harvest. In the next best treatment (Endrin) only an average of 76.87 of the plants produced marketable heads. The plants in the other treatments were so badly infested that few produced heads.

TABLE 4.—*Percentages of plants with marketable heads based on thirty-two plants per replicate*

TREATMENT	REPLICATION					TOTAL	MEAN	MEAN ANGLE
	I	II	III	IV	V			
DDT	31.25	40.62	25.00	43.75	46.87	187.49	37.50	37.64
Guthion	50.00	56.25	46.87	65.62	68.75	287.49	57.50	49.38
Endrin	87.50	62.50	81.25	62.50	90.62	384.37	76.87	62.05
Heptachlor	21.87	25.00	12.50	40.62	28.12	128.11	25.62	30.04
Diazinon	93.75	87.50	75.00	100.00	75.00	431.25	86.25	70.98
Control	9.37	12.50	15.62	18.75	18.75	74.99	14.99	22.64
Total	293.74	284.37	256.24	331.24	328.11	1,493.70		

S.M.D. (T) at 5% = 9.64
1% = 13.15

The estimated profit or loss per hectare when the different insecticides were used shows the relative advantage or disadvantage of using these control materials (table 5). In the estimated total cost of production, the cost of fertilizer and cost and depreciation of spraying equipment were not taken into consideration. No price was available for Guthion, an experimental insecticide.

TABLE 5.—*Estimated cost of insecticides, labor and maintenance and gross profit or loss per hectare when the different insecticides were used*

INSECTICIDE [a]	CURRENT PRICE OF INSECTICIDE PER OUNCE	COST OF INSECTICIDE USED	YIELD IN KILOGRAMS	VALUE OF YIELD [b]	ESTIMATED TOTAL COST OF LABOR, MAINTENANCE AND INSECTICIDES [c]	GROSS PROFIT OR LOSS [d]
	pesos	*pesos*		*pesos*	*pesos*	*pesos*
Diazinon	0.438	973.32	29,180.0	2,918.00	1,473.32	+1,444.68
Endrin	0.333	739.99	24,223.1	2,422.30	1,239.99	+1,182.31
DDT	0.125	563.33	7,393.3	739.33	1,063.33	— 324.00
Heptachlor	0.200	899.99	5,406.6	540.66	1,399.99	— 859.33
Control			3,116.6	311.66	500.00	— 188.34

[a] No price was available for Guthion, an experimental insecticide.
[b] Based at 10 centavos per kilo.
[c] The estimated cost of labor and maintenance for the season of three months duration was ₱500.00 per hectare.
[d] Cost of seeds, equipment, taxes and other expenses not deducted.

Most of the available references on the use of organic synthetic insecticides for the control of caterpillars infesting cabbage in other countries, particularly the United States, point to DDT as effective control for these insects (Apple, 1945; Bronson and Rust, 1951; Bruce and Tauber, 1945; Dillis and Odland, 1948 and 1950; Hackett, 1946; Ivy and Ewing, 1948; Mathewman *et al.*, 1952; Smith and Harrison, 1944; and Sun *et al.*, 1948). Reports of McEwen and Hervey (1956) and Wene (1957) indicate that cabbage worms and the cabbage looper in the United States have developed resistance to DDT and that Endrin alone or in combination with other insecticides gave good control. At present Endrin is widely recommended in the United States for the control of the imported cabbage worm, *Pieris rapae* (L.) and cabbage looper, *Trichoplusia ni* (Hbn.). McEwen and Hervey (1956), working on evaluation of newer insecticides for control of DDT-resistant cabbage looper, found that Endrin, Isodrin, and Shell OS-2046 gave excellent control. Dieldrin, Toxaphene, Parathion and Diazinon did not give good control.

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We have mutual responsibilities to farmers and in getting the results of research into practice. It is only through the application of science to agriculture that more efficient production of eggs, milk and meat will be obtained which will result in better nutrition for your growing population.

—*K. L. Turk*

TEST OF FUNGICIDES FOR THE CONTROL OF TOMATO LEAF MOLD [1]

ROMUALDO G. DE LEON

Tomato leaf mold, caused by *Cladosporium fulvum*, Cke., can be controlled by six weekly sprayings with either Zerlate or Dithane Z-78 at two pounds for every 100 gallons of water. No phytotoxic effect was observed on the sprayed plants. Plants sprayed with Zerlate and Dithane Z-78 showed better growth and yielded larger fruits than the control.

The yield and quality of field-grown tomatoes are often seriously reduced by a number of fruit and foliage diseases. One of these is tomato leaf mold, a destructive disease in the garden as well as in the field, caused by *Cladosporium fulvum* Cke. It causes the blighting, curling and molding of leaves, and if unchecked, the whole plant later presents a brown parched appearance, with hardly a green leaf remaining. Infected flowers fail to set fruit. Even mild attacks tend to devitalize the plants and reduce the size and setting of fruit.

Relatively little experimental work has been done to determine the effect of fungicides on the disease, yet a number of chemicals for its control has been suggested. Darby [2] found that nabam-zinc sulfate, Maneb (Manzate), or a mixture of dichlone and zineb (½: 1-½ : 100; ⅜ : 1 : 100) gave promising control of ghost spot, gray mold, and gray leaf spot of tomato. In a greenhouse test, Guba [3] controlled tomato leaf mold with copper fungicides, organic mercury and vaporized sulfur. Hendrix, *et al.*[4] reported that out of seven fungicides tomato plants treated with Zerlate gave the highest yield, followed by Fermate and Dithane A-10.

Schroeder [5] reported that Zerlate at the rate of two pounds per 100 gallons gave significant results in the control of leaf mold.

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[1] Central Experiment Station Contribution No. 1945. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1956. Prepared in the Department of Plant Pathology under the direction of Visiting Professor Allan G. Newhall and Research Assistant Professor Faustino T. Orillo.

[2] J. F. Darby, *Plant Disease Reporter* **3**, 91-97 (1947).

[3] E. T. Guba, *Massachusetts Agric. Exper. Sta. Bull.* **248**, 1-24 (1929).

[4] W. J. Hendrix, H. Murakishi, and J. A. Lyle, *Hawaii Agric. Exper. Sta. Bull.* **101**, 1-9 (1950).

[5] W. T. Schroeder, *New York State Agric. Exper. Sta. Bull.* **724**, 1-27 (1947).

The use of fungicides for the control of tomato leaf mold has not been tried in the Philippines. This study, therefore, was conducted in the Department of Plant Pathology and in the Central Experiment Station field from October, 1955, to June, 1956, to compare the effectiveness of four fungicides and two antibiotics for the control of tomato leaf mold.

MATERIALS AND METHODS

The fungicides tested were: Zerlate (76 per cent zinc dimethyldithiocarbamate), two lbs. to 100 gallons; Dithane Z-78 (65 per cent ethylene bisdithiocarbamate), two lbs. to 100 gallons; Orthocide 50 Wettable (50 per cent Captan N-trichloromethylmercapto-4-cyclohexane-1, 2-dicarboximide), two lbs. to 100 gallons; and Manzate (70 per cent Manganous ethylene bisdithiocarbamate), two lbs. to 100 gallons. The antibiotics used were: Phytomycin (a Squibb preparation of streptomycin nitrate), eight ml. to a gallon, and Terraclor (a wettable powder containing 50 per cent pentachloro nitrobenzene), 40 grams to a gallon.

Greenhouse test. Thirty-five tomato plants grown in the greenhouse were sprayed with the fungicides, when they were one and one-half months old. Four applications using a double-action hand sprayer were made at weekly intervals. The plants were inoculated with a spore suspension of the fungus two days after each spraying. One week after the last spraying, counts were made on the severity of the disease.

Field test. The experimental layout was a randomized block design, composed of six treatments and a check. Each treatment and the check were replicated seven times. Tomato seeds of the Pearl Harbor variety were planted in seedboxes in the greenhouse. After four weeks these were transplanted in a field and were spaced one foot between plants and one and one-half feet between rows. The plants were not fertilized but were watered every other day. One month after transplanting the first spray was applied with a Hudson sprayer. Tap water was used to dilute the fungicides, which were sprayed the same day they were prepared. Six sprays were applied at weekly intervals. The plants were watered, weeded and inoculated with a spore suspension of the fungus. To insure that the experimental plants were exposed to the disease, infected plants were scattered within the area. One week after inoculation the plants showed symptoms of the disease. The degrees of severity of infec-

tion were determined in the different plots one week after the last spraying. Insects affecting tomato plants were controlled whenever they became abundant. When the fruits reached the right age for harvesting they were picked and weighed.

RESULTS AND DISCUSSION

Greenhouse test. On the basis of percentage of infected leaflets, Zerlate (2-100) was the most effective followed by Dithane Z-78 (2-100), Orthocide (2-100), Terraclor (40 grams to a gallon), Manzate (2-100), and Phytomycin (8 ml. to a gallon). All treatments were better than the control (table 1).

TABLE 1.—*Greenhouse test of fungicides for the control of tomato leaf mold*

TREATMENT	NO. OF PLANTS OBSERVED	NO. OF LEAFLETS COUNTED [a]	NO. OF INFECTED LEAFLETS	PERCENTAGE INFECTION
Zerlate	5	250	29	11.50
Dithane	5	250	56	22.40
Orthocide	5	250	62	24.80
Terraclor	5	250	84	33.80
Manzate	5	250	101	40.40
Phytomycin	5	250	143	57.00
Control	5	250	155	62.00
Total	35	1750	630	

[a] Counts were made one week after the fourth spraying. Four spray applications were made at weekly intervals.

Field test. The efficacy of the fungicides as determined under field conditions showed that at the same rate of application, Zerlate and Dithane Z-78 were the most effective, followed by Orthocide, Terraclor, Manzate and Phytomycin (table 2). Throughout the spraying schedule no burning effect was observed on the plants.

TABLE 2.—*Field test of fungicides for the control of tomato leaf mold*

TREATMENT	NO. OF PLANTS OBSERVED	NO. OF LEAFLETS COUNTED [a]	NO. OF INFECTED LEAFLETS	PERCENTAGE INFECTION
Zerlate	21	3,000	624	20.20
Dithane	21	3,000	959	21.30
Orthocide	21	3,000	1,221	40.70
Terraclor	21	3,000	1,328	40.93
Manzate	21	3,000	1,493	49.70
Phytomycin	21	3,000	1,774	59.13
Control	21	3,000	2,275	75.83
Total	147	21,000	9,674	

[a] Counts were made one week after the sixth spraying. Six spray applications were made at weekly intervals.

Number of fruits. There were no significant differences in the mean number of fruits among the different treatments (table 3). However, variations in fruit size were noted; those in the control were smaller than those in the sprayed plots. This difference was probably due to the adverse effect of the disease on the development of the fruits.

TABLE 3.—*Comparative yield of tomatoes (number of fruits) from the different sprayed plots*

TREATMENT	BLOCK							TOTAL	MEAN
	I	II	III	IV	V	VI	VII		
Zerlate	40	46	43	43	47	43	44	306	43.7
Dithane	44	42	45	46	43	45	39	304	43.4
Orthocide	42	44	42	41	43	44	46	302	43.1
Terraclor	47	43	38	44	40	41	43	296	42.3
Manzate	49	42	43	44	45	46	41	310	44.3
Phytomycin	42	46	41	44	45	40	43	310	44.3
Control	42	44	42	41	44	39	44	296	42.3

Weight of fruits. The weights of fruits in all treatments, except Phytomycin, were highly significant over the control (table 4). On the basis of yield in each treatment, the fungicides tested may be ranked, according to their effectiveness, as follows: Zerlate, Dithane Z-78, Orthocide 50, Terraclor, Manzate, and Phytomycin.

TABLE 4.—*Comparative weight of tomatoes (in grams) from the different sprayed plots*

TREATMENT	BLOCK							TOTAL	MEAN
	I	II	III	IV	V	VI	VII		
Zerlate	1357.0	1420.4	1383.0	1366.4	1410.0	1336.8	1401.1	9674.7	1382.1
Dithane	1321.7	1348.1	1360.8	1319.4	1368.3	1352.1	1330.9	9401.3	1343.0
Orthocide	1313.7	1349.7	1300.7	1332.7	1374.1	1289.8	1360.7	9311.4	1330.2
Terraclor	1309.0	1335.0	1312.4	1318.6	1267.0	1348.7	1343.8	9234.5	1319.2
Manzate	1315.1	1331.6	1270.1	1386.3	1272.7	1324.1	1351.7	9251.6	1321.6
Phytomycin	1329.7	1269.7	1278.0	1276.4	1270.6	1337.3	1310.7	9072.4	1296.1
Control	1283.3	1265.0	1294.4	1265.3	1259.3	1285.0	1239.1	8889.4	1269.9

S.M.D. at 1% = 44.31
5% = 33.07

Pests affecting tomatoes. Insects observed in the field during the experiment were *Chelomenes sexmaculata* Fabr., *Epilachna philippinensis* Dieke, *Heliothis armigera* Hub. and *Plusia chalcytes*

Fabr.[6] These were effectively controlled by spraying the plants with DDT at 19 ml. to a gallon of water.

SUMMARY

1. Leaf mold can be effectively controlled in the field as well as in the greenhouse by spraying the plants with Zerlate and Dithane Z-78 at the rate of two pounds for every 100 gallons of water.
2. Orthocide 50, Terraclor, and Manzate were found to be less effective than either Zerlate or Dithane Z-78 in controlling tomato leaf mold.
3. All the fungicides tested did not cause any burning effect on the leaves of sprayed plants. However, slight stunting was observed on plants treated with Terraclor, Manzate, and Phytomycin.
4. In general, sprayed plants were more vigorous and produced larger fruits of better quality than the control.

[6] Identified by Mr. Leo Rimando of the Department of Entomology.

* * *

The scientists, all of them, have their duties no doubt, but they do not fully use their education if they do not try to broaden their sense of responsibility toward all mankind instead of closing themselves up in a narrow specialization where they find their pleasure.

—*Korzyhski*

ANTHRACNOSE OF TOMATO [1]

RUTH P. CALO

WITH FIVE TEXT FIGURES

Anthracnose of tomato is a disease that primarily affects the fruits and mildly affects the leaves and stems of the plant. It attacks the tomato fruits in the field, in transit, and in the market and causes losses to tomato producers and retailers.

The lesions on the leaves and stems appear as small necrotic spots. Those of the fruits are circular, depressed, soft, and water-soaked. Under ordinary conditions, however, the stems and leaves are not attacked by the fungus.

The disease is caused by *Colletotrichum phomoides* (Sacc.) Chester. It grows abundantly on potato-dextrose agar, potato-sucrose agar, nutrient-dextrose agar, tomato decoction, and malt agar. Cross inoculation experiments showed that the organism could infect pepper and eggplant.

The conidia of the fungus may remain viable for five to six months and may be disseminated by wind, rain, and insects. The disease may be controlled by sanitation, crop rotation, disinfection of seeds, careful handling of fruits, and use of fungicides.

Anthracnose of tomato does little damage to the foliage but is very destructive to ripening fruits. It is found in many tomato growing areas. In the tomato canning region of the central United States it is a prevalent disease, often causing heavy losses. To find out additional information about the disease, particularly its cause in the Philippines, this work was conducted from December, 1954 to February, 1956, in the Department of Plant Pathology and in the vegetable gardens of the College of Agriculture and vicinity. The work was divided into three phases, namely: (1) study of the disease in the field and in the laboratory; (2) study of the morphological and physiological characteristics of the causal fungus; and (3) formulation of control measures on the basis of the results of the study of the disease.

THE DISEASE

History, geographical distribution and economic importance

The anthracnose fungus was first described in Europe by Saccardo (1882), and in the United States by Chester (1891).

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The disease was reported present in Italy (Saccardo, 1882), France (Gruegen, 1902), the Philippines (Ocfemia, 1931) and in the United States: Michigan, Indiana, and Ohio (McLean and Bjornseth, 1946), West Virginia (Giddings, 1917), and in Florida (Weber and Ramsey, 1926).

In 1931 Ocfemia reported that about five per cent of the tomato fruits in the gardens around Los Baños were infected with anthracnose. The disease reduced the market value of the fruits.

Symptoms

On the leaves and stems. The leaves and stems of inoculated plants exhibit few small, brown necrotic spots. However, this symptom does not ordinarily appear on tomato plants in the field.

On the fruits. Fruits which are ripe or beginning to ripen are usually affected by the disease. The lesions are circular, sunken, and water-scaked (fig. 1).

Fig. 1.—Pin-pricked fruits inoculated with bits of mycelial growth of *Colletotrichum phomoides* (Sacc.) Chester photographed 5 days after treatment. (*Photograph taken by the Photographic Division*).

Under moist conditions they spread quickly, become confluent and produce a general decay. Pink masses of conidia or acervuli which gradually turn dark-colored due to the production of setae, are produced later on the dead spots.

THE CAUSAL ORGANISM

Isolation and growth in pure culture. Spore masses from diseased tomato fruits were transferred with a sterilized inoculating needle to plated potato-dextrose agar. Abundant mycelial growth developed on the medium within two days and pinkish spore masses were produced within three days. Transfers were made on sterile potato-dextrose agar slants. Pure cultures of the fungus obtained were used in the morphological and cultural studies and in inoculation experiments.

MORPHOLOGY

Mycelium. The hyphae are produced readily on any culture media used. They are fine, septate and branched, with granular contents (fig. 2A). When young, they are hyaline; with age they turn grayish, and the cell contents become denser. Measurements of 200 hyphal cells from a 10-day-old potato-dextrose agar culture showed that the lengths vary from 6.65 μ to 56.70 μ, and the diameters, from 2.80 μ to 7.70 μ, or an average of $23.40 \pm 0.78 \times 5.26 \pm 0.08$ μ.

Acervuli. The fungus produces numerous acervuli on potato-dextrose agar in three days and on tomato fruits in six days. The acer-

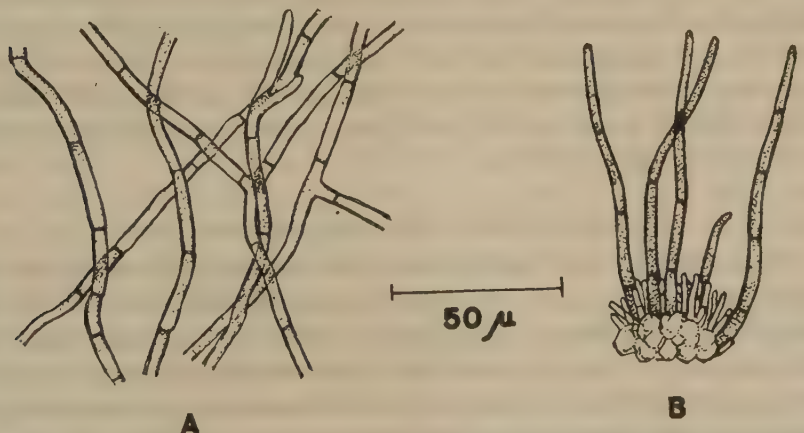

Fig. 2.—Camera lucida drawings of (A) mycelium and (B) portion of an acervulus of *Colletotrichum phomoides* (Sacc.) Chester taken from a 10-day-old potato-dextrose agar culture showing the arrangement of conidiophores and setae. (*Photograph taken by the Photographic Division*).

vuli are separated or clustered (fig. 2b). They are superficial or buried in the medium and subepidermal in the host tissues; pinkish at first and later blackish on account of the change in the color of the hyphae and the production of setae. The setae are variable in number, dark-colored, lighter at the basal portion, 1-4-septate but usually 2-septate and thick-walled (fig. 2b). Measurements of 100 setae showed that the lengths varied from 62.30 μ to 119 μ, and the diameters, from 3.50 μ to 6.65 μ, or an average of 110.84 $\pm$ 4.98 μ $\times$ 4.19 $\pm$ 0.21 μ. Walker (1952) reported lengths from 65 to 112 μ, and Ocfemia (1931), from 61 to 110 μ. Measurements of 100 acervuli from a 10-day-old potato-dextrose agar culture showed that the diameters ranged from 91.00 μ to 175.00 μ. The average diameter was 135.00 $\pm$ 6.34 μ. Diameters of 95 to 150 μ were observed by Walker (1952), and of 98.5 to 165-μ, by Ocfemia (1931).

Conidiophores. The conidiophores are short, slender, thin-walled, hyaline, and granular, arising from a well-developed stroma-like tissue (fig. 2B). Each produces a conidium at its tip. Some are septate. The lengths range from 10.50 μ to 33.60 μ, and the diameters, from 2.80 μ to 5.25 μ, or an average of 22.42 $\pm$ 0.37 $\times$ 3.74 $\pm$ 0.12 μ. Ocfemia (1931) observed lengths from 20.6 to 38.8 μ, or an average of 26.7 μ.

Conidia. The conidia are hyaline, continuous, cylindrical and tapering at one or both ends, and vacuolated (fig. 3A). Measurements of 200 conidia from a 10-day-old potato-dextrose agar culture showed that the lengths vary from 10.50 to 21.00 μ, and the widths from 3.50 to 10.50 μ, or an average of 15.43 $\pm$ 0.04 $\times$ 6.50 $\pm$ 0.06 μ. The majority have length-to-width ratios ranging from 2.00 to 2.99 (table 2). Walker (1952) reported the size to be 4 $\times$ 24 μ; and Ocfemia (1931), 3.4 – 4.7 $\times$ 18.9 – 28.4 μ.

Inducing the production of the ascigerous stage

Experiments were set to induce the fungus to produce the perfect stage by (a) constantly removing superficial growth of the fungus on agar, (b) placing cultures in a desiccator to remove the moisture and incubating the cultures before they were completely desiccated, (c) subjecting cultures to high temperature by immersing test tubes in boiling water for a few seconds and incubating them afterwards, and (d) subjecting the cultures to low temperature by placing them in the refrigerator at varying lengths of time. Not one of these treatments induced the production of perithecia.

PHYSIOLOGY

Growth and conidial production of the fungus on different agar media

The growth characteristics and conidial production of the fungus were studied on 10 different culture media, namely, potato-dextrose agar, potato-sucrose agar, tomato decoction agar, nutrient-dextrose agar, corn meal agar, prune agar, malt agar, onion agar, Czapeck's

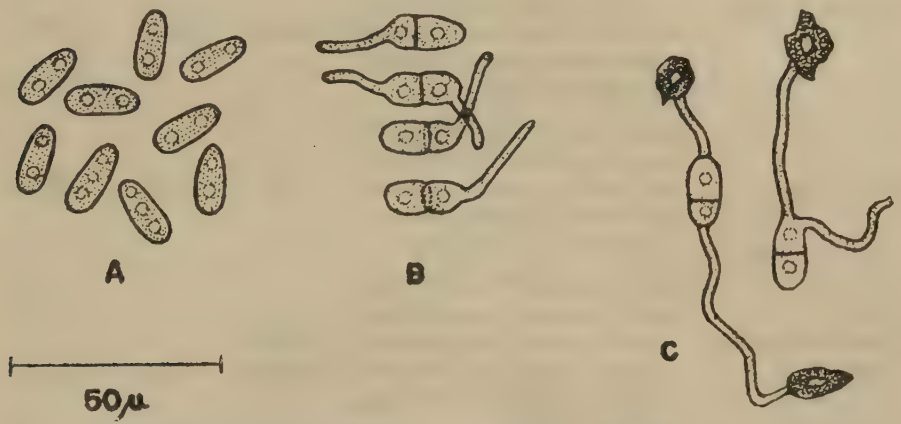

Fig. 3.—Camera lucida drawings of (A) conidia at rest; (B) germinating conidia of *Colletotrichum phomoides* (Sacc.) Chester in distilled water on glass slides after 6 hours; (C) germinating conidia showing appressoria after 24 hours. (*Photograph taken by the Photographic Division*).

agar, and water agar. Triplicate cultures in Petri dishes were made for each medium. A bit of mycelial growth of the fungus was planted on the center of each plate. The inoculum to each plate was made as uniform as possible. The plates were then placed upside down and incubated at room temperature (27 to 28°C). The diameters of mycelial growths were measured and the sporulation of the fungus observed daily for six days. Changes in the color of the fungus colony as well as the media were noted. The colors were determined according to Ridgway's color standards and nomenclature (Ridgway, 1912). The results are summarized in table 1.

The most abundant mycelial growth occurred on potato-dextrose, potato-sucrose, nutrient-dextrose and onion agars. Growth was fairly abundant on tomato-decoction and malt agars. The fungus grew poorly on corn meal, prune, nutrient, and Czapeck's agars. Growth on water agar was very poor. Conidia were very abundant on potato-dextrose agar, potato-sucrose agar and nutrient-dextrose agar. On tomato-decoction, Czapeck's, and malt agars sporulation was fairly

TABLE 1.—*Growth characteristics and conidial production of Colletotrichum phomoides (Sacc.) Chester on various agar media*

MEDIUM	GROWTH CHARACTERISTICS	PRODUCTION OF CONIDIA	DIAMETER OF COLONY AFTER SIX DAYS [a]	AVERAGE [a] DAILY GROWTH
			mm.	*mm.*
Corn-meal agar	Fairly thin, white to dull white mycelial growth produced within 24-48 hours; culture medium changed from pale brown vinaceous to vinaceous-buff	Scarce	80.1	13.35
Prune agar	Scarce white to gray mycelial growth produced within 24-48 hours; culture medium changed from pale dull gray to pallid purplish gray	Scarce	79.33	13.22
Tomato-decoction agar	Fairly abundant, white to dull-white mycelial growth produced within 24-48 hours; culture medium changed from cartridge buff to pale pinkish buff	Fairly abundant	71.60	11.93
Potato-dextrose agar	Very abundant, white to dull-white growth produced within 24-48 hours; culture medium changed from pale pinkish buff to pinkish buff	Very abundant	70.00	11.66
Potato-sucrose agar	Very abundant, white to dull white growth produced within 24-48 hours; culture medium changed from pale pinkish buff to pinkish buff	Very abundant	69.00	11.50
Malt agar	Fairly abundant, white to neutral gray growth produced within 24-48 hours; culture medium changed from light cinnamon-drab to cinnamon-drab	Fairly abundant	68.30	11.38
Nutrient-dextrose agar	Very abundant, white to dull white growth produced within 24-48 hours; culture medium changed from light vinaceous fawn to vinaceous-buff	Abundant	66.30	11.05

TABLE 1 (continued)

MEDIUM	GROWTH CHARACTERISTICS	PRODUCTION OF CONIDIA	DIAMETER OF COLONY AFTER SIX DAYS [a]	AVERAGE [a] DAILY GROWTH
			mm.	*mm.*
Onion agar	Abundant white mycelial growth produced within 24-48 hours; culture medium changed from pale olive buff to tilleul buff	Scarce	62.00	10.33
Nutrient agar	Scarce, white to dull-white growth produced within 48-72 hours; culture medium changed from pale brownish drab to light cinnamon-drab	Scarce	45.30	7.55
Water agar	Very thin white to neutral gray mycelial growth produced within 24-48 hours	None	39.60	6.60
Czapeck's agar	Fairly abundant, white mycelial growth produced within 24-48 hours; culture medium changed from pallid neutral gray to pale dull gray	Fairly abundant	37.00	6.16

[a] Average of three cultures.

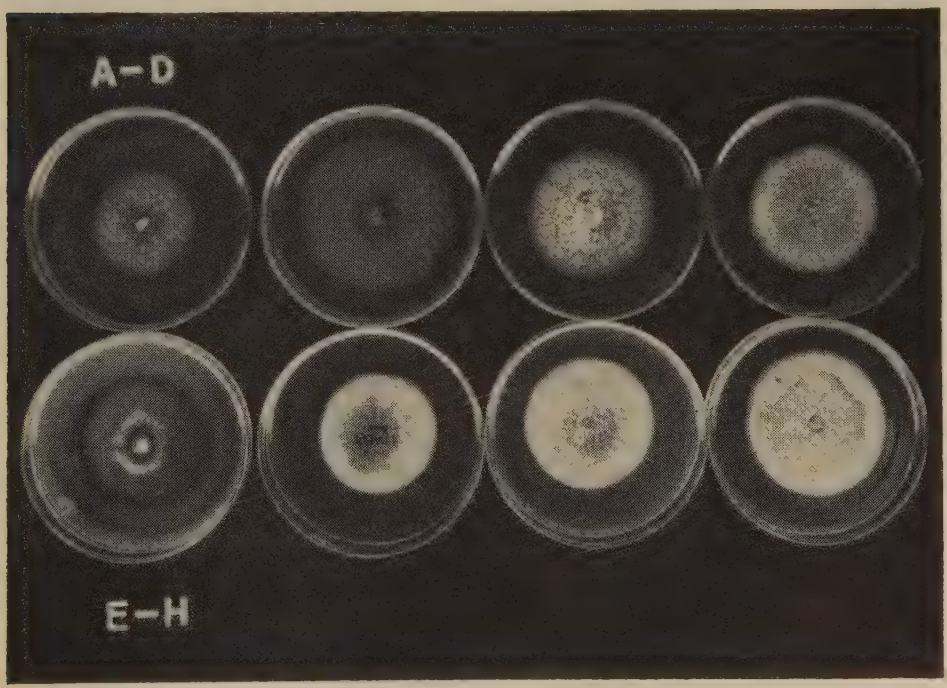

Fig. 4.—Growth and sporulation of *Colletotrichum phomoides* (Sacc.) Chester on various agar media after 6 days. (A) Nutrient agar, (B) prune agar, (C) malt agar, (D) nutrient-dextrose agar, (E) Czapeck's agar, (F) onion agar, (G) potato-sucrose agar, and (H) potato-dextrose agar. (*Photograph taken by the Photographic Division*).

abundant. Sporulation was scarce on corn meal, prune, onion, and nutrient agars. No sporulation was observed on water agar.

The fungus grew very rapidly on corn meal although the mycelium produced was fairly thin and sporulation scarce. Very good growth was observed on potato-dextrose agar, potato-sucrose agar, and nutrient dextrose agar. After 24 to 48 hours the fungus grew very slowly on Czapeck's agar (fig. 4).

Effects of varying hydrogen-ion concentrations on growth and conidial production of the fungus

To determine the effects of varying hydrogen-ion concentrations on the growth and conidial production, the fungus was grown on potato-dextrose agar with pH ranging from 2.5 to 9.5. The agar medium was adjusted to the desired pH by the addition of either sterile 0.5 N HCl or 0.5 N NaOH. Triplicate cultures were made for each pH. The cultures were kept at ordinary room temperature. The diameter of mycelial growth was measured and the production of conidia observed daily for six days. The results are presented in table 2.

TABLE 2.—*Growth and acervulus production of Colletotrichum phomoides (Sacc.) Chester on potato-dextrose agar of different hydrogen-ion concentrations*

pH OF MEDIA	COMPARATIVE ABUNDANCE OF MYCELIUM	COMPARATIVE ABUNDANCE OF ACERVULUS	DIAMETER OF COLONY AFTER SIX DAYS [a]	AVERAGE [a] DAILY GROWTH
2.5	None	None	—	—
3.0	None	None	—	—
3.5	Very scarce	None	6.67	1.11
4.0	Scarce	Fairly abundant	28.00	4.67
4.5	Fairly abundant	Fairly abundant	48.67	8.11
5.0	Abundant	Abundant	70.00	11.67
5.5	Abundant	Very abundant	73.67	12.28
6.0	Very abundant	Very abundant	72.67	12.11
6.5	Very abundant	Very abundant	72.67	12.11
7.0	Abundant	Abundant	70.67	11.78
7.5	Abundant	Abundant	65.33	10.89
8.0	Fairly abundant	Fairly abundant	64.00	10.67
8.5	Fairly abundant	Fairly abundant	54.00	9.00
9.0	Fairly abundant	Fairly abundant	46.00	7 .67
9.5	Fairly abundant	Fairly abundant	45.00	7.50

[a] Average of three cultures.

Mycelial growth and sporulation were abundant on the medium with pH varying from 5.0 to 7.5. The best mycelial growth and spor-

ulation were obtained at pH 5.5 (fig. 5). Thin mycelial growth with no apparent sporulation appeared on pH 3.5. There was no growth at pH 2.5 and 3.0. Kendrick and Walker (1948) noted that the fungus growth was retarded at pH 2.9; moderate at 3.9 and good at 4.9 to 9.9. They also found no sporulation at 2.9, most abundant sporulation at 3.9, slightly less at 4.9 to 6.9; decreased rapidly above 6.9; and rare at 9.9.

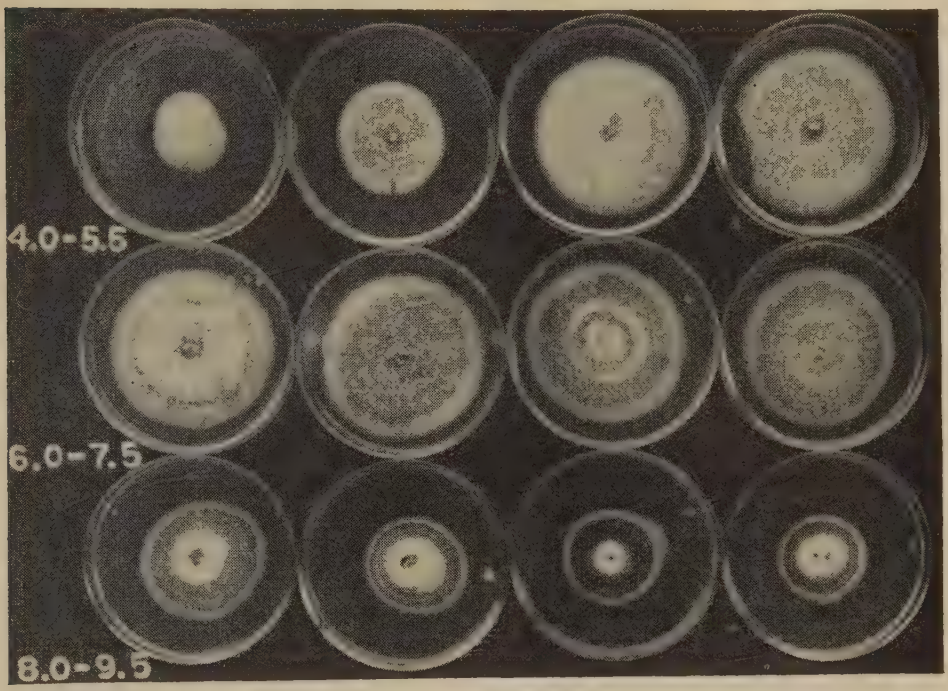

Fig. 5.—Effects of varying hydrogen-ion concentrations on growth and conidial production of *Colletotrichum phomoides* (Sacc.) Chester. (*Photograph taken by the Photographic Division*).

Germination of conidia

Potato-dextrose agar, distilled water, and tap water were used as media for spore germination. Conidia were taken from potato-dextrose agar culture and mounted in tap water and distilled water in van Tieghem cells and on thin layers of potato-dextrose agar on sterilized glass slides. These were kept in Petri dishes and observed hourly for the germination of conidia.

The conidia germinated within 5 to 10 hours on potato-dextrose agar and 6 to 12 hours in distilled water. Usually a conidium pro-

duced a hyaline germ tube near one end. In some cases, it produced two, one from either end; very seldom were two germ tubes produced on one end (fig. 3B). Each germinating conidium produced a septum near or at the middle perpendicular to its long axis. Chlamydospore-like bodies, or appressoria were produced at the tips of the germ tubes within 18 to 24 hours (fig. 3C).

Viability of the fungus

The viability of conidia on diseased ripe tomato fruit and on potato-dextrose slants was observed at one-month intervals. The conidia were suspended in distilled water in van Tieghem cells and their germination was observed. The tests showed that the conidia from diseased tomato fruits remained viable for six months; those from the potato-dextrose agar medium remained viable for five months.

TAXONOMY

The tomato pathogen in this study agrees in gross morphological characteristics with the species named and described by Chester (1891) and with that studied by Ocfemia (1931). The measurements of the fruiting structures, conidiophores, conidia, and setae lie within the range reported by these workers. Furthermore, the symptoms produced on tomato and subsequently on pepper and eggplant are strikingly similar to those previously reported. The fungus causing the anthracnose of tomato in the Philippines is, therefore, identical with *Colletotrichum phomoides* (Sacc.) Chester. Saccardo (1882) reported this fungus to be *Gloesporium phomoides* because he failed to observe setae. Swank (1953) established the connection of this fungus with the ascigerous stage, and therefore, gave the name *Glomerella phomoides* Swank.

Under Philippine conditions, most of the ascomycetes produce only the conidial or asexual stage. This is, perhaps, due to the favorable climate which prevails in the Philippines.

PATHOGENICITY

To test the pathogenicity of the fungus, tomato seeds and plants at different stages of development, as well as green and ripe fruits, were inoculated. In all the experiments, five varieties of tomato were used, namely, Susung Kalabaw, Sta. Cruz, Latuna Dwarf Globe, Turrialba, and Bottleneck.[2]

[2] Except for Susung Kalabaw variety, the seeds were furnished by Dr. T. L. York and Mr. F. D. Roquia of the Department of Agronomy.

Inoculation of tomato seeds

Experiment 1. On January 1, 1956, two hundred seeds from each tomato variety were disinfected with 1:1000 mercuric chloride solution for 30 seconds and rinsed three times with sterile distilled water. One hundred seeds were mixed with mycelium and conidia of the fungus from a 15-day-old potato-dextrose agar culture and planted in pots of sterilized soil to serve as control.

The percentages of seed germination of the five varieties were:

TREATMENT	VARIETIES				
	Latuna Dwarf Globe	Bottleneck	Turrialba	Susung Kalabaw	Sta. Cruz
Control	78	82	82	92	88
Inoculated	68	68	70	72	86

The results showed that the fungus when present in the seed reduces the percentage of germination.

Experiment 2. On January 2, 1956, two hundred seeds of each variety were again disinfected with 1:1000 mercuric chloride solution and rinsed in three changes of sterile distilled water. One hundred seeds were planted in pots of sterilized soil infested with a 15-day-old culture of the fungus. The other 100 seeds were planted in another pot of sterilized soil to serve as control.

The percentages of seed germination were:

TREATMENT	VARIETIES				
	Latuna Dwarf Globe	Bottleneck	Turrialba	Susung Kalabaw	Sta. Cruz
Control	83	98	73	95	82
Inoculated	82	92	71	90	78

The results showed that the fungus does not affect too much seed germination when mixed with the soil before the seeds are sown.

Inoculation of tomato plants at different stages of development

Experiment 3. On July 30, 1955, fifty 23-day-old seedlings of each variety were inoculated by spraying with a spore suspension from a 10-day-old culture of the fungus. Twenty-five seedlings were pin-pricked with sterilized pins. The rest were not injured. Another

fifty seedlings of each variety, 20 of which were pin-pricked, were sprayed with sterile water to serve as control. The inoculated and control seedlings were placed inside the damp chamber for 48 hours. Then they were taken outside the laboratory and placed under the shade for further observation. Symptoms appeared on the inoculated seedlings after three days.

Experiment 4. On September 5, 1955, six 60-day-old tomato plants of each variety were inoculated with a spore suspension of the fungus and six others were used as checks. The same treatment was given to the plants as in experiment 3.

The inoculated plants also became diseased.

Experiment 5. On October 6, 1955, six 91-day-old bearing tomato plants of each variety were sprayed with spore suspension of a 15-day-old culture of the fungus. Three plants of each variety were pricked on the leaves, stems, and fruits before spraying; the rest were not injured. Six other plants consisting of injured and uninjured individuals and sprayed with sterile distilled water served as control.

Characteristic symptoms appeared only on the injured leaf, stem and fruits and none on the uninjured ones. Control plants remained healthy.

Experiment 6. On June 1, 1955, 10 ripe and 10 green tomato fruits were inoculated with bits of mycelial growth and spores of the fungus. Five of the 10 ripe and five of the 10 green tomato fruits were pin-pricked. For the control five ripe and five green fruits were injured and another five from each group were not injured and these were inoculated with bits of potato-dextrose agar without the fungus. The inoculated and control fruits were placed in large Petri dishes bottom-lined with wet filter paper.

Symptoms appeared on the inoculated injured fruits within two to three days. The spot in each fruit was circular and sunken with abundant pinkish masses of spores. Within five days, the growth became greenish black because of the change in the color of the hyphae and abundance of dark brown setae. The uninjured tomato fruits remained uninfected. Kendrick and Walker (1948) secured infection of stem and leaf without wounding but not so with ripe and green fruits. The susceptibility of fruits increases as they approach maturity. Control fruits remain normal.

Reisolation of the fungus. In all inoculation experiments, the fungus was reisolated from the infected tomato fruits. Its morphological and cultural characters were similar to those of the first isolate.

Varietal susceptibility and resistance

Varieties Susung Kalabaw and Turrialba showed less susceptibility to the disease.

HOST RANGE

Fruits of pepper and eggplant were inoculated to determine whether or not the fungus would infect plants other than tomato. Plants grown in pots were also sprayed with spore suspension of the fungus. Treated fruits and plants and their respective controls were given the same conditions as those used in the previous inoculation experiments.

Lesions produced on the leaves and on the fruits of pepper and eggplant were similar to those of tomato. Unpricked leaves and fruits, however, were not infected. Lesions on the leaves of both plants appeared within four to five days. On fruits of pepper, the lesions were produced within two days; it took five to six days before symptoms appeared on eggplant.

LIFE HISTORY OF THE CAUSAL FUNGUS IN RELATION TO PATHOGENESIS

Seasonal occurrence of the disease in the field. The disease is prevalent during the wet season and is absent during the dry season. The fungus is favored by warm and moist weather conditions which prevail during the rainy season. Kendrick and Walker (1948) reported that a temperature of 24° to 28°C is most favorable for sporulation, germination of spores, growth and infection.

Method of penetration. Inoculation experiments showed that the fungus is capable of penetrating only injured ripe fruits. The injuries caused by insects, soil particles blown by the wind, and by man during cultural operations may provide avenues for entrance.

Methods of dissemination. In the field, conidia may be carried by surface wash during rainy days. In transit and in storage, the fungus may be spread by mixing infected and healthy fruits.

Methods of tiding over from season to season. Infected fruits and other plant parts left in the field after the tomato season usually

contain an abundance of mycelium and conidia of the fungus. The fungus persists on these infected debris in the soil between crop seasons. When the weather conditions are favorable, they infect the new tomato plants during the next season. Kendrick and Walker (1948) believe that most fruit infection is by inoculum from the soil.

The fungus may also remain dormant in tomato seeds. Infected seeds, when planted, may germinate, and the plants may eventually become infected.

CONTROL MEASURES

Sanitation. Infected tomato plants and fruits should be gathered and burned as soon as the disease is observed. Sources of inoculum for the next tomato crop should be eliminated.

Crop rotation. Crop rotation with non-solanaceous plants should be practised since eggplant and pepper are susceptible to the disease.

Selection and disinfection of seeds. Only seeds from healthy fruits should be used for planting. Since even healthy looking seeds may harbor the fungus, they should be disinfected before they are planted, to prevent loss of seeds and seedlings.

Care in harvesting and picking of fruits. The grower or tomato picker should handle the fruits carefully during harvesting and pricking or rough handling may injure the fruits. These injuries serve as entrance for the pathogen. All infected fruits should be discarded to prevent contamination of healthy fruits while in transit and in storage.

Use of fungicides. Slide tests were conducted in the laboratory to determine the effectivity of seven fungicides (Zerlate, Parzate, Vancide, Gycop "53", COCS, Copper A compound and Dithane Z-78). Vancide, Dithane Z-78, Zerlate, Gycop "53" and Parzate were each applied at 2 lbs. per 100 gallons of water, and COCS at 6 lbs. per 100 gallons of water. COCS, Dithane, and Parzate completely prevented conidal germination. In the rest of the treatments two to three germinating conidia were observed. Other workers found Zerlate effective against anthracnose. Spraying is recommended when infection is prevalent.

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Poultry has been used to prove to my people that there are other important agricultural products besides rice. It has been used variously as a medium of exchange. It has also maintained one other important industry, the fish industry: chicken manure is an excellent fish feed.

—*Luang Suwan*

THE INFLUENCE OF FIVE KINDS OF STOCKS ON SZINKOM MANDARIN (*CITRUS RETICULATA* BLANCO)[1]

CARLOS A. CADIZ

Of the five kinds of stocks tested for Szinkom mandarin, rough lemon and calamandarin seemed to be the most promising. Batangas mandarin, Szinkom and Suekat were successfully budded, but the scions did not do so well in these stocks as in the first two.

When propagated by seeds, the varieties of citrus fruits grown commercially do not reproduce true to type. They must be propagated asexually by budding onto a rootstock of some citrus species. The discovery of the best stock for a given variety has remained one of the most important problems, even in countries advanced in fruit production.

Bachelor and Webber [2] reported that not all citrus species can be used as rootstocks. The stock and the scion must not only be capable of uniting but must also result in a long-lived productive tree.

According to Brown [3] the citrus industry in Peshawar, India, has been a failure because of lack of adequate knowledge on the reactions between the stock and the scion.

De Leon [4] stated that the use of an unsuitable rootstock for citrus propagation can cause loss to the grower. The resulting tree may be short-lived because of incompatibility between the stock and the scion varieties or because of susceptibility of the rootstock to bark disease.

Bayubay [5] found significant differences in time of union of Tahiti lime with each of the five kinds of stocks he tested.

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[1] Central Experiment Station Contribution No. 1947. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1955. Prepared in the Department of Agronomy under the direction of Dr. L. G. Gonzalez.

[2] L. D. Bachelor and H. J. Webber, "The Citrus Industry: The Production of the Crop," University of California Press, Berkeley, 1948, Vol. II, pp. 67-69.

[3] W. Robertson Brown, *Pusa Agric. Res. Bull.*, **93**, 1-7 (1920).

[4] Jose de Leon, *Dept. of Agric. and Nat. Res. Pop. Bull.*, **40**, 1-45 (1951).

[5] S. Bayubay, "Influence of Five Kinds of Stocks on the Rate of Growth and Development of Tahiti Lime, *Citrus aurantifolia* Swingle." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1942. Unpublished.)

Merino [6] found that of the five varieties of citrus he used, calamandarin and Szinkom were the most promising stocks for Batangas mandarin.

This work was undertaken to determine the influence of five kinds of stock on Szinkom mandarin. The work was conducted at Lipa Station of the Bureau of Plant Industry and at the Department of Agronomy, College of Agriculture from December, 1953, to August, 1955.

MATERIALS AND METHODS

All the planting materials were secured from Lipa Citrus Experiment Station.[7] The varieties used were Szinkom mandarin (*Citrus reticulata* Blanco) as control stock, Calamandarin (*Citrus reticulata Blanco* × *Citrus mitis* Blanco), rough lemon (*Citrus hystrix* D. C.), Batangas mandarin (*Citrus reticulata* Blanco), and Suekat.[8]

For each kind of stock, 50 healthy and uniform one-year-old seedlings were planted in the nursery on December 18, 1953. Szinkom mandarin buds were gathered from a single healthy tree, typical of the variety, which had a record of consistently high production. The plants were budded when they had been fully established on January 6, 1954. Two weeks later, the living buds of each stock were counted.

On January 31, 1954, when a good union seemed to have been effected, twenty budded plants of comparable vigor were selected from each kind of stock. These were balled and transplanted one foot apart in randomized 2-feet spaced rows.

The young citrus trees were cultivated regularly, and the soil was kept moist throughout the growing season.

Ammonium sulfate was applied every three months at the rate of 50 grams per tree. It was scattered carefully at the base to prevent it from coming into direct contact with the tree trunk.

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[6] S. Merino, "The Influence of Five Kinds of Stocks on Batangas Mandarin (*Citrus reticulata* Blanco)." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1954. Unpublished.)

[7] Special thanks are due Mr. D. Altamirano, Station Superintendent, for his help during the study.

[8] Mr. Benemerito of Lipa Citrus Experiment Station helped identify the different stocks used.

Monthly measurements in height from a fixed base and in girth five centimeters above the point of union were made. The diameters of the scions were measured with a Vernier caliper. The leaves were counted every month, and the percentage of the successful union in each stock recorded. The susceptibility of the different kinds of stock to pests and diseases was also observed.

One hundred holes, each 1 × 1 × ½ m. and spaced at 7 × 7 m. were dug and refilled with good top soil composed of a mixture of two kerosene cans of rice straw compost and one kerosene can of fine river sand.

On August 25, 1955, the one hundred budded citrus trees were balled, brought to the College of Agriculture from Lipa, and planted the following day. The randomized complete design with five replications was used. Each replication had five single-row plots and each plot was planted to four budded plants of each kind.

RESULTS AND DISCUSSION

Comparative percentage of compatibility between scions and stocks. Table 1 shows the percentage of union between Szinkom as scion and the five varieties of citrus as stocks. Szinkom on rough lemon had a compatibility of 78 per cent; on calamandarin, 72; on Szinkom (control), 68; on Batangas mandarin, 62; and on Suekat, 52. These data were gathered from 50 plants per stock. The buds that did not grow to a height of one inch were not considered successfully united and were therefore disregarded.

TABLE 1.—*Percentage of budding success of the five different stocks with Szinkom mandarin as the scion*

KIND OF STOCK	NUMBER OF SUCCESSFUL GRAFTS	BUDDING SUCCESS
Szinkom (control)	34	68
Calamandarin	36	72
Rough lemon	39	78
Batangas mandarin	31	62
Suekat	26	52

Increase in height of scions as influenced by the different stocks. Table 2 shows the monthly increase in height of 20 experimental plants after budding, taken during a period of 14 months. The analysis of variance gave a computed F-value which exceeded tabular F-

value at one and five per cent levels of significance. Applying the S.M.D. at a level of five per cent, rough lemon differed significantly from Suekat, Szinkom, and Batangas mandarin. The increase in height of calamandarin was also significantly more than that of Suekat, Szinkom, and Batangas mandarin, but it did not differ significantly from that of rough lemon. At one per cent level rough lemon and calamandarin were significantly higher than any of the other stocks used. The mean heights of the scions in the different stocks were: rough lemon, 55.3 cm.; calamandarin, 54.9 cm.; Batangas mandarin, 44.5 cm.; Szinkom, 42.4 cm.; and Suekat, 38.9 cm.

TABLE 2.—*Increase in height of Szinkom mandarin scions as influenced by the five different stocks* [a]

PLANT NUMBER	KIND OF STOCK				
	Szinkom Mandarin (control)	Batangas mandarin	Suekat mandarin	Rough lemon	Calamandarin
	cm.	*cm.*	*cm.*	*cm.*	*cm.*
1	44.8	39.8	38.1	45.3	64.1
2	31.2	53.2	50.2	61.4	45.0
3	42.0	48.9	31.9	58.2	59.3
4	47.3	36.8	36.1	46.0	63.5
5	41.7	46.3	32.0	53.8	65.3
6	53.9	39.1	48.5	41.4	60.3
7	58.2	52.3	59.0	49.8	64.1
8	24.6	48.6	41.9	54.4	62.2
9	31.8	48.4	49.9	61.2	42.3
10	30.4	48.6	35.3	59.3	44.0
11	50.3	34.6	31.2	67.6	52.8
12	41.5	53.0	35.8	60.4	45.9
13	47.5	46.2	37.1	51.5	46.0
14	44.5	39.8	33.9	49.6	58.3
15	42.2	40.1	31.6	51.6	60.9
16	48.9	42.4	35.2	57.1	52.0
17	35.6	51.4	42.9	60.0	50.3
18	47.0	46.3	33.2	54.6	55.1
19	46.6	32.0	37.1	59.6	58.0
20	38.4	42.1	38.8	62.3	48.3
Total	848.4	889.9	779.7	1105.1	1097.7
Mean	42.4	44.5	38.9	55.3	54.9

[a] Number of leaves of scion 14 months after budding.

S.M.D. (T) at 5% = 9.64
1% = 13.15

Increase in number of leaves as influenced by the different stocks. With regards to the mean increase in the number of leaves,

the scions budded to rough lemon ranked first with 56.8; those to Suekat, second with 55.8; and those to calamandarin, third with 55.0. However, the difference between the mean increase of leaves of rough lemon and that of calamandarin was not significant. The increase in number of leaves of the scion budded to rough lemon and Suekat stocks was significantly greater than scions budded to Szinkom with only 49.7 and to Batangas mandarin with 49.3 (table 3).

TABLE 3.—*Increase in number of leaves of Szinkom mandarin scions as influenced by the five different stocks* [a]

PLANT NUMBER	KIND OF STOCK				
	Szinkom mandarin (control)	Batangas mandarin	Suekat mandarin	Rough lemon	Calamandarin
1	38	48	71	50	63
2	33	55	63	53	61
3	33	49	37	55	60
4	76	43	59	47	63
5	66	45	48	50	53
6	56	65	62	49	50
7	53	58	52	58	62
8	42	49	42	53	68
9	56	48	63	59	47
10	58	56	60	66	43
11	50	47	59	62	45
12	44	58	53	58	49
13	66	40	57	52	48
14	41	43	46	56	65
15	38	51	66	70	55
16	41	52	63	63	56
17	35	46	55	59	53
18	48	44	52	53	58
19	67	43	54	58	61
20	53	47	54	65	40
Total	994	987	1116	1137	1100
Mean	49.7	49.3	55.8	56.8	55.0

[a] Number of leaves of scion 14 months after budding.

S.M.D. at 5% = 5.36

Increase in girth of the scions. The analysis of variance of the total increase in girth failed to reveal any significant difference among the different stocks (table 4).

Susceptibility to pests and diseases. As shown in table 5, the scions on rough lemon suffered most from attacks of citrus leaf

miner, which is caused by *Phyllocnitia citrella Stanton*.[9] Fifteen of the twenty plants were affected, whereas only 13 on Suekat, 11 on Batangas mandarin, and 10 on Szinkom were attacked. The most resistant were those on calamandarin with only six affected.

Since this work was only a part of a long-range study, no definite conclusions can be drawn for the present. However, the desired experimental budded materials have been successfully planted in orchard form and are now awaiting further study.

TABLE 4.—*Increase in girth of Szinkom mandarin scions budded to five different stocks (cm.)*[a]

PLANT NUMBER	KIND OF STOCK				
	Szinkom mandarin (control)	Batangas Mandarin	Suekat Mandarin	Rough lemon	Calamandarin
1	3.8	3.0	3.9	3.5	3.7
2	3.0	3.6	3.2	3.5	3.6
3	3.2	3.3	3.6	3.6	4.2
4	5.4	3.6	3.5	3.1	3.5
5	3.6	4.3	3.6	3.5	4.2
6	3.6	3.0	3.5	3.2	4.3
7	3.8	3.4	4.3	3.6	3.9
8	3.6	3.8	3.6	3.1	4.0
9	3.4	4.1	3.8	4.1	3.4
10	3.2	4.0	3.2	4.2	3.8
11	4.8	3.5	2.8	3.8	3.2
12	3.4	3.8	2.9	3.6	3.3
13	3.0	3.1	3.6	3.5	4.1
14	3.2	3.4	3.0	4.1	4.2
15	4.0	3.6	2.9	3.3	3.3
16	2.6	3.2	3.3	3.7	4.0
17	3.6	3.5	3.4	4.0	3.2
18	3.6	3.6	3.3	4.5	4.1
19	4.2	3.5	3.4	4.2	3.5
20	3.0	3.4	3.5	4.5	4.1
Total	72.0	70.7	68.3	74.6	75.6
Mean	3.6	3.5	3.4	3.7	3.8

[a] Increase in girth 14 months after budding.

[9] Identified by Messrs. Bombay and Macabasco of Lipa Citrus Experiment Station.

TABLE 5.—*Reaction to citrus leaf miner of the scions budded to five different stocks* [a]

KIND OF STOCK	NUMBER OF PLANTS ATTACKED	PERCENTAGE	INTENSITY OF DAMAGE
Szinkom mandarin (control)	10	50	slight
Calamandarin	6	30	slight
Rough lemon	15	75	heavy
Batangas mandarin	11	55	slight
Suekat	13	65	heavy

[a] Based on 20 plants.

SUMMARY AND CONCLUSIONS

1. In percentage of bud union, rough lemon ranked first with 78, followed by calamandarin with 72, Szinkom with 68, Batangas with 62, and Suekat, with 52.

2. Comparative study of the increase in height and in girth as influenced by the stocks showed that rough lemon and calamandarin are the most promising stocks for Szinkom.

3. Rough lemon ranked first in the mean increase in number of leaves formed during the experiment with 56.8, followed by Suekat with 55.8, outranking calamandarin with 55.0. The three had significantly more leaves than Szinkom and Batangas mandarin.

4. No serious pest and disease except citrus leaf miner were observed.

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